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The Cyclone Global Navigation System (CYGNSS) Earth Venture Mission

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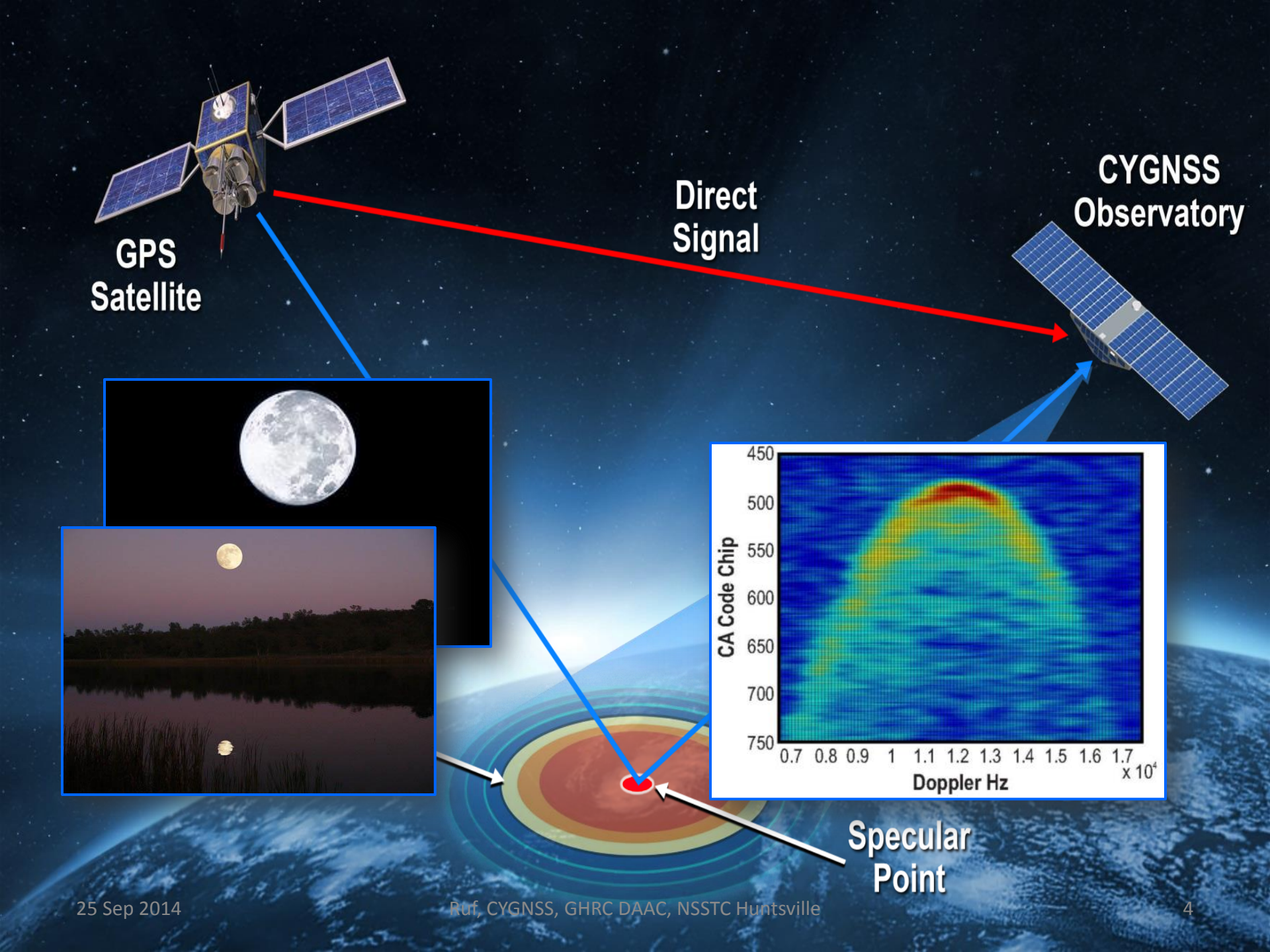
CYGNSS Mission Overview

- The Cyclone Global Navigation Satellite System (CYGNSS) is the NASA Earth Venture Mission selected in June 2012
- CYGNSS consists of 8 separate microsatellites in LEO, each with 4 GPS bi-static radar receivers
  - Mission lead/Science Ops (University of Michigan)
  - Spacecraft/Integration/Mission Ops (Southwest Research Institute)
  - Science payload provider (Surrey Satellite Technology)
- The driving science objective is rapid sampling of ocean surface winds in the inner core of tropical cyclones

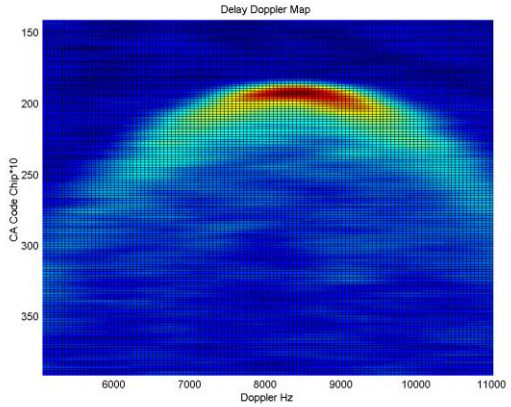
CYGNSS Science Goals and Objectives

- CYGNSS Science Goal
  - Understand the coupling between ocean surface properties, moist atmospheric thermodynamics, radiation, and convective dynamics in the inner core of a tropical cyclone (TC)
- CYGNSS Objectives
  - Measure ocean surface wind speed **in all precipitating conditions**, including those experienced in the TC eyewall
  - Measure ocean surface wind speed in the TC inner core **with sufficient frequency to resolve genesis and rapid intensification**
- CYGNSS uses a new measurement technique and a new satellite mission architecture
  - Measure the distortion of GPS signals scattered from the ocean surface to determine ocean surface roughness and wind speed
  - Use small satellites so many can be flown to improve sampling

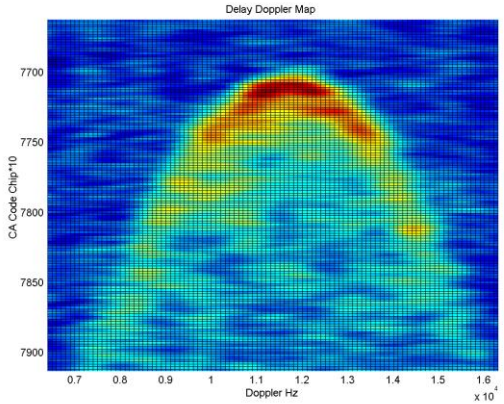

GPS
Satellite
Direct
Signal
CYGNSS
Observatory
CA Code Chip
450
500
550
600
650
700
750
0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7
x 10^4
Doppler Hz
Specular
Point

Spaceborne Empirical Demonstration of Ocean Wind Speed Retrievals by GNSS-R

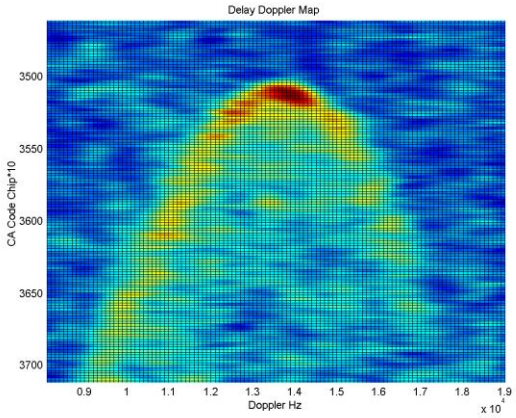
GNSS-R instrument (early version of CYGNSS science payload) deployed on UK-DMC-1 mission, launch 2003



- Winds ~ 2 m/s

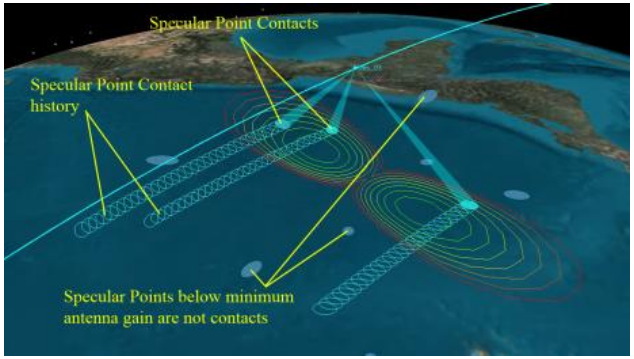


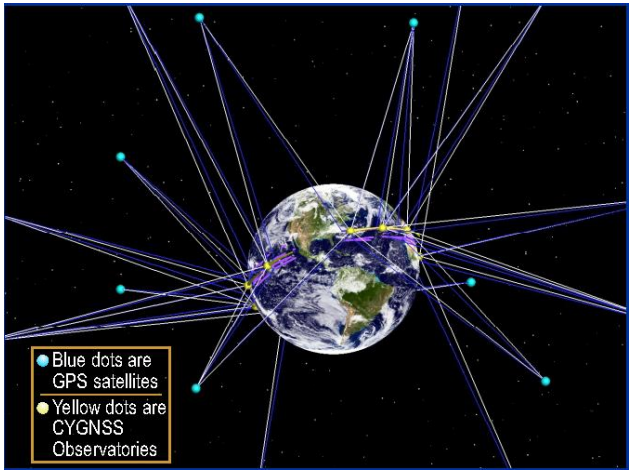
- Winds 7 m/s



- Winds 10 m/s

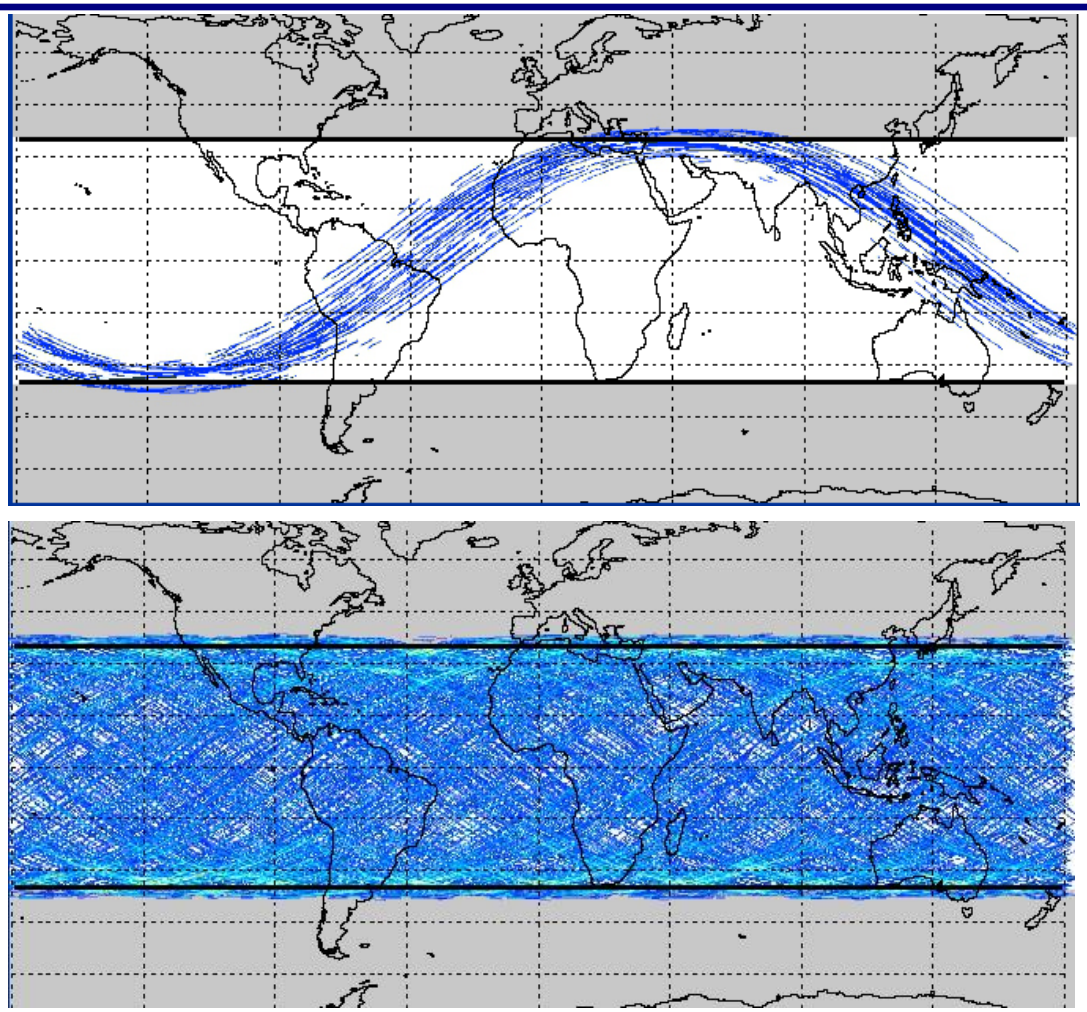
CYGNSS Spatial Sampling



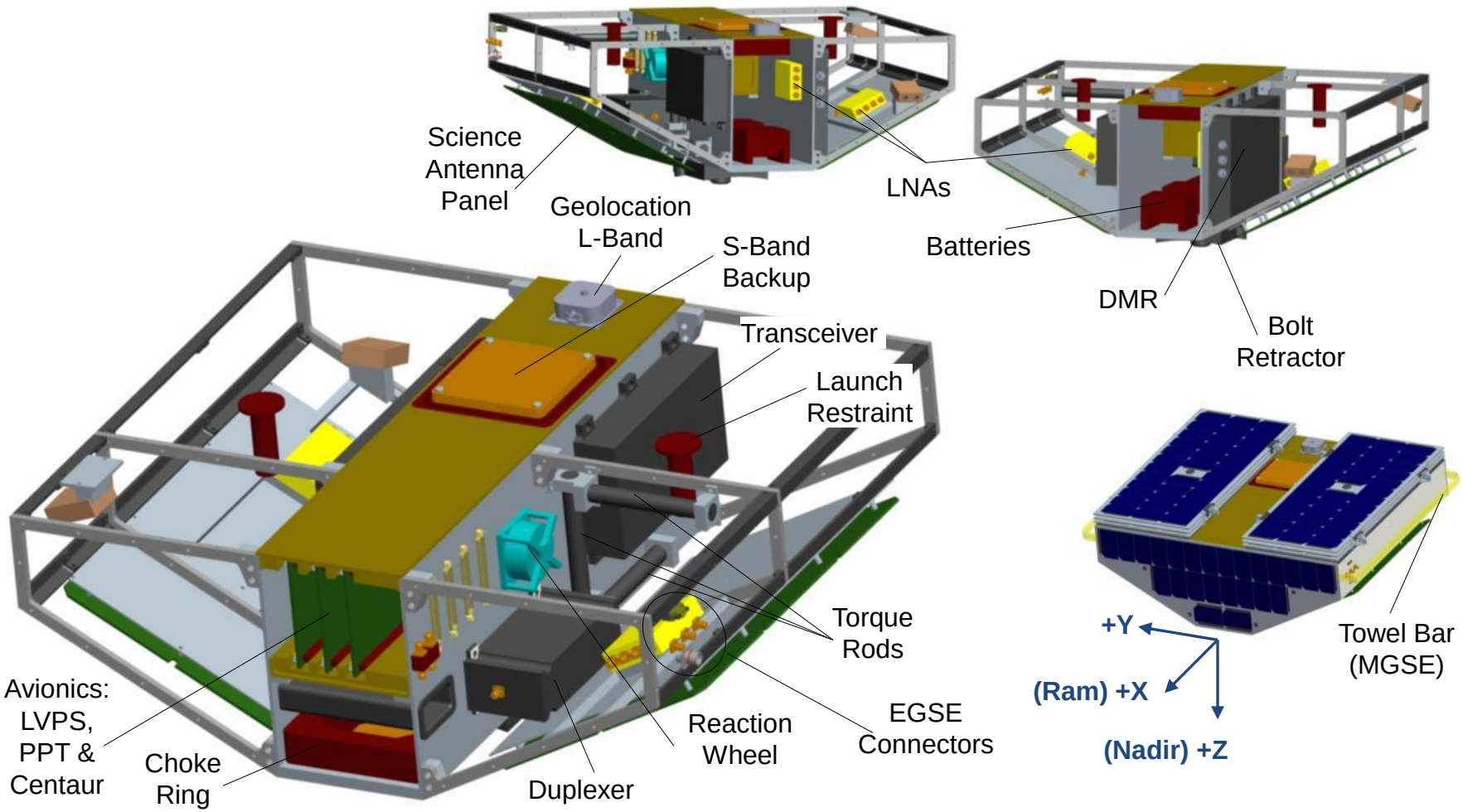


CYGNSS Earth Coverage

- 90 min (one orbit) coverage showing all specular reflection contacts by each of 8 s/c
- 24 hr coverage provides nearly gap free spatial sampling within +/- 35^{o} orbit inclination

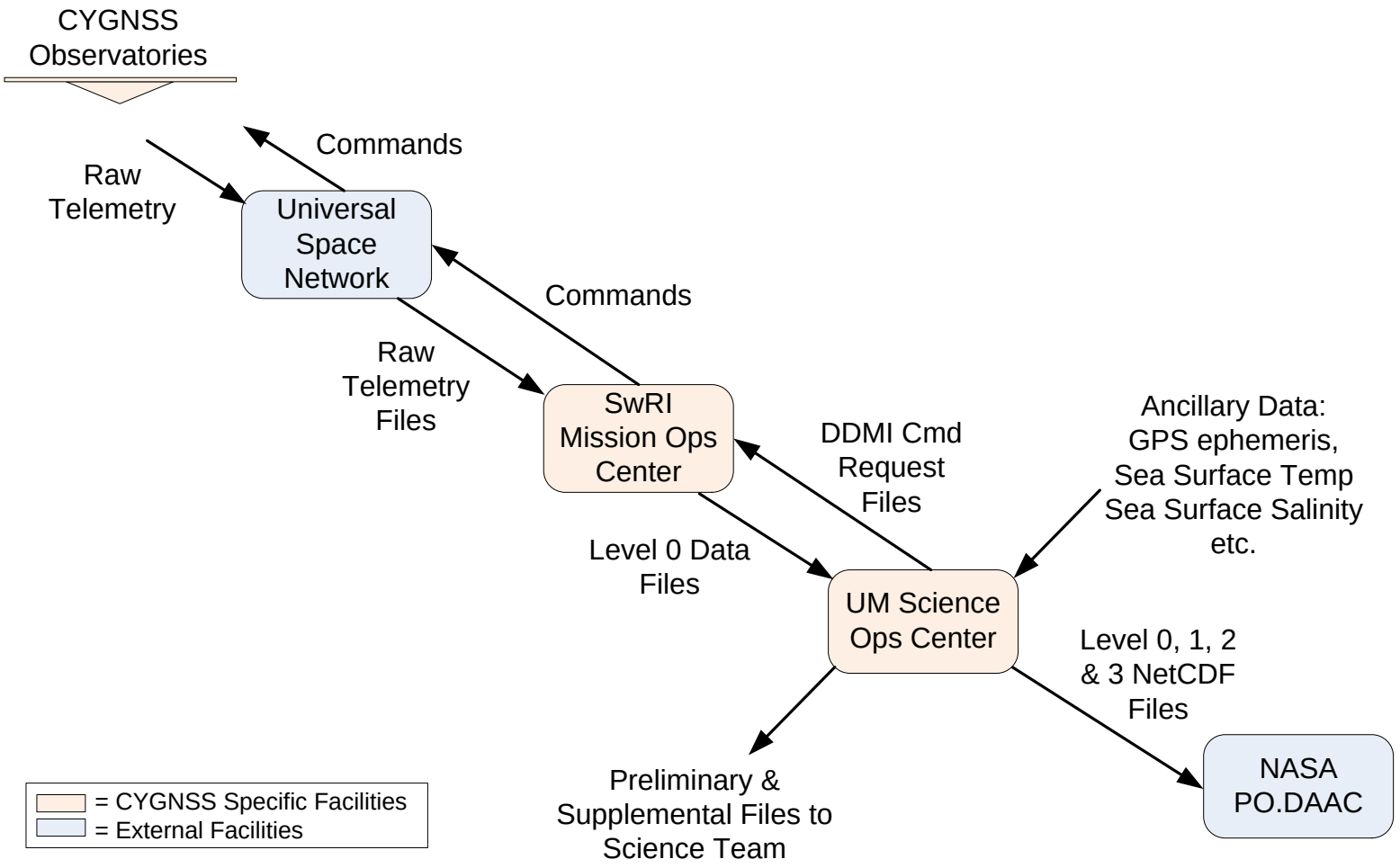


CYGNSS Observatory (exploded view)



Observatory Separation

CYGNSS Ground Segment



Science Data Products (1 of 3)

- Level 0 through Level 3 science data products are stored in netCDF format using Climate and Forecast (CF) metadata conventions
- Data latency from TM downlink to PO.DAAC is six days maximum

Science Data Products (2 of 3)

Level	Description
0	• Unprocessed DDMs and metadata • Contains all information from the raw science TM files • Raw counts, not engineering units • DDMs still compressed • File granularity: ~48 hours, single observatory
1a	• Decompressed, calibrated DDMs, power in Watts • Complete metadata converted to engineering units • File granularity: one UTC day, entire constellation
1b	• Calibrated DDMs, bistatic radar cross section • Precision geolocated specular points • Complete metadata • Uncertainty • File granularity: one UTC day, entire constellation

Science Data Products (3 of 3)

Level	Description
2a	• Time tagged wind speed of a 25 x 25 km cell centered on the specular point • Complete metadata • Uncertainty • File granularity: one UTC day, entire constellation
2b	• Time tagged mean square slope of a 25 x 25 km cell centered on the specular point • Complete metadata • Uncertainty • File granularity: one UTC day, entire constellation
3a	• Wind Speed, gridded in time and space (¼° latitude, longitude grid) • Number of wind readings per cell • File granularity: three UTC hours, entire constellation
3b	• Wind Speed optimized for observing system experiment data assimilation , variable grid size

Project Schedule

Date	Milestone
Dec 2012	Project start
Jun 2013	System Requirements Defined
Jan 2014	Overall System Design Completed
Jan 2015	Detailed Design Completed
Mar 2015 – Jun 2016	Build, Assemble & Test the Spacecraft
Jul-Aug 2016	Integrate Spacecraft and Launch Vehicle
Oct 2016	LAUNCH
Oct 2016 – Mar 2017	Spacecraft commissioning, Science payload and algorithm calibration and validation
Oct 2016 – Sep 2018	On-orbit Mission Lifetime
After Sep 2018	Extended mission